Translation

PATENT COOPERATION TREATY

PCT/FR2003/003590

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference BIF023238/BQ	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/FR2003/003590	International filing date (*day/month/year*) 04 décembre 2003 (04.12.2003)	Priority date (*day/month/year*) 09 décembre 2002 (09.12.2002)
International Patent Classification (IPC) or national classification and IPC H01L 21/20, 21/18, 21/762, 21/58		
Applicant COMMISSARIAT A L'ENERGIE ATOMIQUE		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 6 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 5 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
09 juin 2004 (09.06.2004)	15 March 2005 (15.03.2005)
Name and mailing address of the IPEA/EP Facsimile No.	Authorized officer Telephone No.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/FR2003/003590

I. Basis of the report

1. With regard to the **elements** of the international application:*

☒ the international application as originally filed

☒ the description:

pages 1-23, as originally filed

pages _____, filed with the demand

pages _____, filed with the letter of _____

☒ the claims:

pages _____, as originally filed

pages _____, as amended (together with any statement under Article 19

pages _____, filed with the demand

pages 1-35, filed with the letter of 11 February 2005 (11.02.2005)

☒ the drawings:

pages 1/6-6/6, as originally filed

pages _____, filed with the demand

pages _____, filed with the letter of _____

☐ the sequence listing part of the description:

pages _____, as originally filed

pages _____; filed with the demand

pages _____, filed with the letter of _____

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language _____ which is:

☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).

☐ the language of publication of the international application (under Rule 48.3(b)).

☐ the language of the translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

☐ the description, pages _____

☐ the claims, Nos. _____

☐ the drawings, sheets/fig _____

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* *Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rule 70.16 and 70.17).*

** *Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.*

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/FR 03/03590

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-35	YES
	Claims		NO
Inventive step (IS)	Claims	1-35	YES
	Claims		NO
Industrial applicability (IA)	Claims	1-35	YES
	Claims		NO

2. Citations and explanations

1. **Reference is made to the following documents:**

D1: FR-A-2 789 518 (COMMISSARIAT ENERGIE ATOMIQUE) 11 August 2000;

D2: FEIJOO D ET AL: "Prestressing of bonded wafers" PROC. FIRST INT. SYMP. ON SEMICONDUCTOR WAFER BONDING: SCIENCE, TECHNOLOGY AND APPLICATIONS, PHOENIX, AZ, USA, 13-18 OCT. 1991, pages 230-238.

2. **The subject matter of claim 1 is novel (PCT Article 33(2)) and involves an inventive step (PCT Article 33(3)).**

2.1 Document D2, which is considered to be the prior art closest to the subject matter of claim 1, describes steps of (the references between parentheses apply to said document):

- assembling the two basic structures (D2, page 230, the abstract);
- creating a difference in tangential stress state

between the two surfaces to be assembled, which difference is generated by curving both of said two basic structures to be assembled by exerting mechanical force on each of said two structures (D2, page 230, the abstract; page 233, paragraph 3; figure 1); and

- producing, within the assembled structure, a predetermined stress state under specific conditions relative to the assembly conditions (D2, page 233, paragraph 3).

2.2 It follows that the subject matter of claim 1 **differs** from this known method in that:

- the two structures are curved **before** said two basic structures are brought into contact.

2.3 **The subject matter of claim 1 is, therefore, novel (PCT Article 33(2)).**

2.4 The **problem** that the present invention is intended to solve can therefore be considered to be that of enhancing the quality of the assembled structure.

2.5 **The solution to this problem, as proposed in claim 1 of the present application, is considered to involve an inventive step (PCT Article 33(3)), for the following reasons:**

Document D2 does not disclose that the structures are curved before they are brought into contact. On the contrary, it appears that, in D2, the two structures are firstly brought into contact and then curved by exerting mechanical force thereon (D2,

page 230, paragraph entitled "Experimental Procedure"; figure 1).

Even though document D1 describes two structures that are curved **before** being brought into contact (D1, page 21, lines 9-15; page 20, lines 9-16), D1 does not describe the exertion of mechanical force on said two basic structures in order to curve same. In D1, the two structures are curved by applying curve-inducing stress-adaptation layers thereto.

It is not considered to be obvious for a person skilled in the art to use, with a corresponding effect, the features in document D2, which describes the exertion of **mechanical force after** the two structures have been brought into contact, in combination with the features in document D1, which describes the application of **stress-adaptation layers before** said two structures are brought into contact.

2.6 **It follows that the subject matter of claim 1 involves an inventive step (PCT Article 33(3)).**

3. **Claims 2-35 are dependent on claim 1 and, as such, therefore also fulfil the PCT requirements of novelty and inventive step.**

4. **The subject matter of claims 1-35 fulfils the requirements set forth in PCT Article 33(4).**

CLAIMS

1. Method of producing a complex structure wherein respective connecting faces of two basic structures (1, 3; 1, 3, 19; 20, 21, 23, 25) are brought into contact and assembled, characterized in that, before bringing them into contact, a tangential stress state difference imposed by curving each of the two basic structures to be assembled is created between the two faces to be assembled by applying mechanical forces to each of the two structures, this difference being selected to obtain within the assembled structure a predetermined stress state under given conditions relative to the assembly conditions.

2. Method according to claim 1 of producing a complex structure, characterized in that one of the structures is deformed before offering up the second structure facing it.

3. Method according to either claim 1 or claim 2 of producing a complex structure, characterized in that the stress state differences is generated by means of stresses generated independently in each basic structure.

4. Method according to any one of claims 1 to 3 of producing a complex structure, characterized in that the two structures are curved so that the two faces to be assembled are respectively concave and convex.

5. Method according to claim 4 of producing a complex structure, characterized in that the two structures are curved so that the two faces to be assembled are complementary.

6. Method according to claim 5 of producing a complex structure, characterized in that the two structures are curved so that the two faces to be assembled are respectively spherical concave and spherical convex.

7. Method according to any one of claims 1 to 6 of producing a complex structure, characterized in that the mechanical forces applied to the basic structure result

from the creation of a pressure difference between the two faces of said structure.

8. Method according to claim 7 of producing a complex structure, characterized in that the pressure difference between the two faces of the structure to be curved so that it has a concave face to be assembled is created by aspirating said structure onto a concave preform having a suitable profile selected as a function of that to be imparted to the face to be assembled and on which the structure rests locally at its periphery.

9. Method according to claim 7 of producing a complex structure, characterized in that the pressure difference between the two faces of the structure to be curved so that it has a concave face to be assembled is created by aspirating said structure into a cavity, the structure resting locally at its periphery on a seal bordering the cavity.

10. Method according to claim 6 of producing a complex structure, characterized in that the mechanical forces applied are the result of deforming the structure between complementary first and second preforms, one of which is concave and the other of which is convex, with profiles selected as a function of that to be imparted to the face to be assembled.

11. Method according to claim 10 of producing a complex structure, characterized in that the first preform is one of the concave structures to be assembled that has already been curved to the selected profile.

12. Method according to claim 10 or claim 11 of producing a complex structure, characterized in that the second preform has aspiration channels for keeping the structure curved, once the first preform has been removed.

13. Method according to any one of claims 1 to 6 of producing a complex structure, characterized in that the mechanical forces are applied simultaneously to the two

structures to be assembled by deforming the two structures between two preforms having profiles selected as a function of those to be imparted to the faces to be assembled.

14. Method according to any one of claims 1 to 13 of producing a complex structure, characterized in that mechanical forces are applied to at least one of the substrates by means of a preform consisting of a mold.

15. Method according to claim 14 of producing a complex structure, characterized in that said preform consists of a porous mold.

16. Method according to any one of claims 1 to 13 of producing a complex structure, characterized in that mechanical forces are applied to the substrates with the aid of at least one deformable preform.

17. Method according to any one of claims 1 to 13 of producing a complex structure, characterized in that the two structures are assembled by molecular bonding.

18. Method according to claim 14 of producing a complex structure, characterized in that the two faces to be assembled are treated to facilitate bonding.

19. Method according to any one of claims 1 to 18 of producing a complex structure, characterized in that the substrates are assembled by direct contact, the surface of at least one of these substrates being adapted to prevent air from being trapped between the assembled surfaces.

20. Method according to claim 19 of producing a complex structure, characterized in that at least one of the substrates is pierced.

21. Method according to claim 20 of producing a complex structure, characterized in that said substrate is pierced at its center.

22. Method according to claim 21 of producing a complex structure, characterized in that at least one of the substrates includes at least one dead-end channel discharging at the edge of the substrate.

23. Method according to any one of claims 1 to 16 of producing a complex structure, characterized in that the substrates are assembled by means of a flow layer.

24. Method according to any one of claims 1 to 23 of producing a complex structure, characterized in that assembly is carried out at a temperature higher than room temperature.

25. Method according to claim 24 of producing a complex structure, characterized in that the substrates are heated by contact with heated preforms.

26. Method according to claim 25 of producing a complex structure, characterized in that the preforms are heated to respective different temperatures.

27. Method according to any one of claims 1 to 26 of producing a complex structure, characterized in that the method further includes a technology step including a change of temperature, the tangential stress state difference between the two faces to be assembled being selected so that, during this step, the stresses within the assembled structure remain below a predetermined stress threshold.

28. Method according to claim 27 of producing a complex structure, characterized in that the technology step is a heat treatment step.

29. Method according to any one of claims 1 to 28 of producing a complex structure, characterized in that the method further includes, after assembling the two basic structures, a step of thinning one of these two structures to produce a thin film, the tangential stress state difference between the two faces to be assembled being selected to impose a given stress level within the resulting thin film.

30. Method according to claim 29 of producing a complex structure, characterized in that the thin film is assembled to another basic structure by creating, prior to

assembly, a tangential stress state difference between the two faces to be assembled, that difference being selected to obtain within the new assembled structure a predetermined stress state under given conditions relative to the assembly conditions.

31. Method according to any one of claims 1 to 30 of producing a complex structure, characterized in that the method further includes an epitaxy step for producing an epitaxially grown film (23) of a material on an external face of the complex structure, the tangential stress state difference being selected so that, at the epitaxy temperature, that external face has a lattice parameter compatible with epitaxial growth of the required material.

32. Method according to claim 31 of producing a complex structure, characterized in that the structure on which epitaxy is to be effected is a thin film (22) obtained by thinning said structure after assembly.

33. Method according to either claim 31 or claim 32 of producing a complex structure, characterized in that the method further includes the following steps:

- assembling the complex structure including the epitaxially grown film (23) onto another structure (25) via respective connecting faces by creating, a tangential stress state difference between these two new faces to be assembled prior to assembly,

- thinning the complex structure to expose a face of the epitaxially grown thin film (23), and

- epitaxially growing a new material (26) on the exposed face of the thin film,

the tangential stress state difference between the two new faces to be assembled being selected so that the lattice parameter of the epitaxially grown thin film (23) is compatible with epitaxial growth of the new material (26) to be grown epitaxially.

34. Method according to any one of claims 1 to 33,

characterized in that it is carried out in a controlled atmosphere.

35. Method according to any one of claims 1 to 33, characterized in that it is carried out in a hydrogen atmosphere.